

WHAT IS CLAIMED IS:

1 1. An apparatus comprising:
2 a processing chamber configured to carry out chemical vapor deposition
3 (CVD), the chamber including a platform configured to receive a wafer;
4 an ampoule vaporizer fastened to the chamber, configured to convert a
5 fluorine-free tungsten-containing solid compound to vapor; and
6 a funnel-shaped dispersion plate configured to receive a gas mixture including
7 the vapor and direct the gas mixture toward a surface of the wafer in a substantially uniform
8 manner.

1 2. The apparatus of claim 1 further comprising a mass flow controller
2 fastened to the chamber, configured to receive the vapor from the ampoule vaporizer and
3 regulate the flow of the vapor.

1 3. The apparatus of claim 2 further comprising a mixing fixture
2 configured to receive the vapor from the mass flow controller, mix the vapor with one or
3 more other gas(es) to form the gas mixture, and deliver the gas mixture to the dispersion
4 plate.

1 4. The apparatus of claim 1 wherein the solid compound is tungsten
2 hexacarbonyl ($W(CO)_6$).

1 5. The apparatus of claim 2 wherein the ampoule vaporizer and the mass
2 flow controller are fastened to a top lid of the chamber.

1 6. The apparatus of claim 1 wherein the chamber further includes a face
2 plate between the dispersion plate and the wafer, the face plate having a plurality of passages
3 extending from a top surface to a bottom surface of the plate, and being configured to present
4 a suitably uniform thermal profile to the wafer so that the wafer may be uniformly heated.

1 7. The apparatus of claim 1 wherein the dispersion plate comprises:
2 a body having a center axis, an input face, an output face, and a thickness
3 between the faces; and

4 an input opening along the center axis in the input face for receiving a stream
5 of vapor, the input opening extending radially from the center axis to an output opening in
6 the output face through which the stream of vapor exits.

1 8. The apparatus of claim 7 wherein the input opening extends along the
2 center axis to form a hole before extending radially to the output opening, the hole having a
3 substantially hour-glass shape.

1 9. The apparatus of claim 8 wherein the hole extends radially from the
2 center axis to the output opening forming an angle having a value at the output opening in the
3 range of 60-85 degrees.

1 10. An apparatus comprising:
2 a processing chamber configured to carry out chemical vapor deposition
3 (CVD); and
4 an ampoule vaporizer fastened to the chamber, configured to convert a
5 fluorine-free tungsten-containing solid compound to vapor delivered to the chamber for use
6 in the CVD.

1 11. The apparatus of claim 10 further comprising:
2 a mass flow controller fastened to the chamber, configured to receive the
3 vapor from the ampoule vaporizer and regulate the flow of the vapor.

1 12. The apparatus of claim 10 wherein the solid compound is tungsten
2 hexacarbonyl ($W(CO)_6$).

1 13. The apparatus of claim 11 wherein the ampoule vaporizer and the mass
2 flow controller are fastened to a top lid of the chamber.

1 14. The apparatus of claim 11 further comprising a mixing fixture
2 configured to receive the vapor from the mass flow controller, mix the vapor with one or
3 more other gas(es), and deliver the resulting gas mixture to the chamber interior.

1 15. The apparatus of claim 14 wherein the chamber comprises:
2 a platform configured to receive a wafer; and

3 a funnel-shaped dispersion plate configured to receive the gas mixture from
4 the mixing fixture and direct the gas mixture toward a surface of the wafer in a substantially
5 uniform manner.

1 16. The apparatus of claim 15 wherein the dispersion plate comprises:
2 a body having a center axis, an input face, an output face, and a thickness
3 between the faces;
4 an input opening along the center axis in the input face for receiving a stream
5 of vapor, the input opening extending radially from the center axis to an output opening in
6 the output face through which the stream of vapor exits.

1 17. The apparatus of claim 16 wherein the input opening extends along the
2 center axis to form a hole before extending radially to the output opening, the hole having a
3 substantially hour-glass shape.

1 18. The apparatus of claim 17 wherein the hole extends radially from the
2 center axis to the output opening forming an angle having a value at the output opening in the
3 range of 60-85 degrees.

1 19. The apparatus of claim 15 wherein the chamber further includes a face
2 plate between the dispersion plate and the wafer, the face plate having a plurality of passages
3 extending from a top surface to a bottom surface of the plate, and being configured to present
4 a suitably uniform thermal profile to the wafer so that the wafer may be uniformly heated.

1 20. A chemical vapor deposition method for forming a layer of tungsten on
2 a wafer, the method comprising:

3 placing a wafer in a processing chamber;

4 converting a fluorine-free tungsten-containing solid compound to vapor using
5 an ampoule vaporizer fastened to the chamber;

6 delivering the vapor to a mixing fixture configured to mix the vapor with one
7 or more other gas(es); and

8 introducing the gas mixture into the processing chamber for forming the layer
9 of tungsten.

1 21. The method of claim 20 wherein the solid compound is tungsten
2 hexacarbonyl ($W(CO)_6$).

1 22. The method of claim 20 further comprising:
2 delivering the vapor from the ampoule vaporizer to the mixing fixture through
3 a mass flow controller fastened to the chamber, the mass flow controller regulating the flow
4 of the vapor.

1 23. The method of claim 22 wherein the ampoule vaporizer and the mass
2 flow controller are fastened to a top lid of the chamber.

1 24. The method of claim 22 further comprising:
2 directing the gas mixture provided by the mixing fixture toward a surface of
3 the wafer in a uniform manner using a funnel-shaped dispersion plate.

1 25. The method of claim 24 wherein the dispersion plate includes a body
2 having a center axis, an input face, an output face, a thickness between the faces, and an input
3 opening along the center axis in the input face for receiving a stream of vapor, the input
4 opening extending radially from the center axis to an output opening in the output face
5 through which the stream of vapor exits.

1 26. The method of claim 25 wherein the input opening extends along the
2 center axis to form a hole before extending radially to the output opening, the hole having a
3 substantially hour-glass shape.

1 27. The method of claim 26 wherein the hole extends radially from the
2 center axis to the output opening forming an angle having a value at the output opening in the
3 range of 70-85 degrees.

1 28. The method of claim 24 further comprising:
2 directing the gas mixture through a face plate positioned between the
3 dispersion plate and the wafer, the face plate having a plurality of passages extending from a
4 top surface to a bottom surface of the plate, and being configured to present a suitably
5 uniform thermal profile to the wafer so that the wafer may be uniformly heated.

1 29. A processing chamber configured to carry out chemical vapor
2 deposition (CVD), comprising:
3 a platform configured to receive a wafer; and

4 a funnel-shaped dispersion plate configured to receive a gas mixture and direct
5 the gas mixture toward a surface of the wafer in a substantially uniform manner.

1 30. The chamber of claim 29 further comprising a mixing fixture
2 configured to receive a fluorine-free tungsten-containing precursor and one or more carrier
3 gas(es) to form the gas mixture, and deliver the gas mixture to the dispersion plate.

1 31. The chamber of claim 29 wherein the fluorine-free tungsten-containing
2 precursor is tungsten hexacarbonyl ($W(CO)_6$) vapor.

1 32. The chamber of claim 29 wherein the dispersion plate comprises:
2 a body having a center axis, an input face, an output face, and a thickness
3 between the faces;
4 an input opening along the center axis in the input face for receiving the gas
5 mixture, the input opening extending radially from the center axis to an output opening in the
6 output face through which the gas mixture exits.

1 33. The chamber of claim 32 wherein the input opening extends along the
2 center axis to form a hole before extending radially to the output opening, the hole having a
3 substantially hour-glass shape.

1 34. The chamber of claim 33 wherein the hole extends radially from the
2 center axis to the output opening forming an angle having a value at the output opening in the
3 range of 60-85 degrees.

1 35. The chamber of claim 30 further comprising a face plate between the
2 dispersion plate and the wafer, the face plate having a plurality of passages extending from a
3 top surface to a bottom surface of the plate, and being configured to present a suitably
4 uniform thermal profile to the wafer so that the wafer may be uniformly heated.